We Claim:

1. A motion capture system comprising:

at least four stationary radio frequency receivers around a defined area;

a first radio frequency transmitter disposed at a determinable position relative to the receivers;

a plurality of radio frequency transmitters affixed to at least one movable object within the vicinity of the defined area;

the receivers receiving radio frequency signals transmitted by the transmitters; and

a processing system for processing the signals received by the transmitters to determine positional information regarding the movable object within the vicinity of the defined area, the processing system using signals received from the first transmitter as a reference for determining positions of the transmitters affixed to the movable object.

2. The system of claim 1 further comprising means for determining said first transmitter position relative to the receivers.

3. The system of claim 1 wherein the stationary receivers have respective receiver clocks, and the stationary receivers do not have circuitry which synchronizes their receiver clocks from one stationary receiver to another.

4. The method of claim 1 further comprising using said determined position information to position a computer generated object within a motion picture scene.

5. The method of claim 1 further comprising using said determined position information to position a computer generated object within a video game scene.

6. The method of claim 1 wherein the at least one movable object comprises at least two relatively moving objects within a product manufacturing process, and wherein the method further comprises using said determined position information to analyze said product manufacturing process.

7. The system of claim 1 wherein the movable object is a motion picture camera, and wherein the plurality of transmitters affixed thereto comprise at least 3 transmitters disposed at positions on the camera sufficient to determine pitch, yaw, and roll of the camera.

8. The system of claim 7 wherein the motion picture camera is a hand held motion picture camera.

9. The system of claim 1 wherein at least one of the plurality of radio frequency transmitters affixed to the movable object comprises a patch which is activated by removal of a backing layer therefrom.

10. The system of claim 9 wherein the patch is a flexible patch having an adhesive layer covered by the backing layer, the transmitter being activated by removal of the backing layer to expose the adhesive layer.

11. The system of claim 1 wherein each of the transmitters affixed to the object transmits a synchronization code and a tag identification code, the tag identification code being unique to each tag, the synchronization code and the tag identification code being modulated onto a carrier frequency.

12. The system of claim 11 wherein the synchronization code is OEED hex.

13. The system of claim 11 wherein the tag identification codes are selected for low pairwise cross-correlation values.

14. The system of claim 11 wherein the tag identification codes are vectors in a binary extended quadratic residue code space.

15. The system of claim 11 wherein the tag identification codes represent values produced by the code generator polynomial

$$\prod_{n \in Q} (x-\alpha^n)$$

where $Q = \{1, 2, 3, 4, 6, 7, 8, 9, 12, 14, 16, 17, 18, 21, 24, 25, 27, 28, 32, 34, 36, 37, 42\}$

16. The system of claim 1 wherein the processing system computes respective positions of the transmitters on the object without using any Global Positioning System (GPS) data or inertial sensor data transmitted by the transmitters on the object.

17. The system of claim 1 wherein each of the transmitters transmits signals at a transmission rate that is an integer multiple of both 24 transmissions per second and 30 transmissions per second.

18. The system of claim 1 wherein each of the transmitters attached to the movable object comprises:

a backing layer;

circuitry affixed to the backing layer for generating a radio frequency waveform;

an antenna for transmitting the waveform;

an adhesive applied to the backing layer;

a removable portion applied to the adhesive;

a sensor for detecting when the removable portion is removed; and

a transmitter controller for enabling the device to begin transmitting the radio frequency waveform when the sensor detects that the removable portion has been removed.

19. A method of tracking movement of at least one object, the method comprising:

providing a plurality of radio frequency receivers defining sensors;

providing a first radio frequency transmitter, the first radio frequency transmitter defining a reference tag;

providing a plurality of radio frequency transmitters on the at least one object, the transmitters defining marker tags;

determining a position of the reference tag to define a reference tag known position; and

processing the known position of the reference tag and the radio frequency signals received at the sensors from the marker tags and from the reference tag to determine respective positions of the marker tags.

20. The method of claim 19 wherein the processing includes:

computing respective reference tag pseudorange measurements between the reference tags and the sensors;

computing respective marker tag pseudorange measurements between each of the marker tags and the sensors;

computing respective single differences between the marker tag pseudorange measurement and the reference tag pseudorange measurement for each of the sensors;

computing respective double differences between the single differences for pairs of sensors;

using the double differences to form a set of simultaneous equations; and

solving the simultaneous equations to compute the position of the marker tag.

21. The method of claim 19 wherein each of the marker tags transmits a synchronization code and a respective tag identification code, the tag identification code being unique to each tag, the synchronization code and the tag identification code being modulated onto a carrier frequency.

22. The method of claim 21 wherein the processing includes determining a code phase indicating the position of a given marker tag to within a range corresponding to a bit position of said synchronization code.

23. The method of claim 19 wherein the processing further includes determining a carrier phase, the carrier phase resolving the position of the given marker tag within said bit position to within less than one wavelength at the carrier frequency.

24. The method of claim 19 further comprising using data produced according to the method to insert computer generated images within a motion picture scene.

25. The method of claim 19 further comprising using data produced according to the method to create a part of a video game scene.

26. The method of claim 19 further comprising using data produced according to the method within a virtual reality simulator.

27. The method of claim 19 further comprising using data produced according to the method for sports training.

28. The method of claim 19 further comprising using data produced according to the method for illustrating athletic action during a broadcast of a sporting event.

29. A method of tracking movement of an object comprising:

placing at least one transmitter on at least one object, the transmitter transmitting a radio frequency signal;

receiving the signal at a plurality of radio frequency receivers;

wherein neither the transmission of the signal nor the receiving of the signal at a given receiver is controlled in time with respect to any of the other receivers;

processing timings of the signal received at the receivers to track movement of the object.

30. The method of claim 29 wherein the movement takes place and is effectively tracked within a capture zone having horizontal dimensions of larger than 25 meters by 25 meters.

31. The method of claim 29 wherein the movement takes place and is effectively tracked within a capture zone having a diagonal dimension of at least 100 meters.

32. The method of claim 29 wherein the at least one transmitter comprises at least 1000 transmitters.

33. The method of claim 29 wherein the at least one transmitter comprises a plurality of transmitters that transmit respective waveforms which have been selected to minimize pairwise cross-correlation between transmitters.

34. The method of claim 29 wherein the transmitter transmits at a duty cycle of less than 5 percent.

35. A method of tracking movement of an object comprising:

placing a plurality of radio frequency sensors about a capture zone;

placing at least one reference radio frequency transmitter defining a reference tag within the capture zone;

determining a location of the marker tag with respect to the sensors;

placing a plurality of radio frequency transmitters defining marker tags on the object;

receiving at the sensors signals transmitted by the reference tag and the marker tags; and

processing the signals transmitted by the reference tag and the marker tags to determine positions of the object as the object moves through the capture zone.

36. The method of claim 35 wherein the marker tags are not synchronized either with respect to each other or with respect to the reference tag.

37. A method of tracking movement of an object comprising:

disposing radio frequency transmitters defining respective marker tags at each of a plurality of separate positions on the object, wherein each transmitter transmits a respective waveform corresponding at least in part to a unique marker tag identification code;

receiving the transmitted waveforms, the received versions of the transmitted waveforms defining received waveforms;

associating the respective received waveforms with the respective marker tags that transmitted those waveforms without demodulating the waveforms to respective bit patterns; and

processing the respective waveforms to determine locations of the respective marker tags.

38. The method of claim 37 wherein the waveform processing includes correlating sampled values of each of the received waveforms against samples of stored tag identification codes waveforms; and

identifying a particular marker tag as the marker tag that transmitted a particular received waveform based on a high correlation between said samples of said particular received waveform and a particular stored tag identification code waveform.

39. The method of claim 38 wherein the correlating is performed using a digital signal processing microcircuit.

40. The method of claim 38 wherein the stored tag identification code waveforms have been filtered to approximate an idealized tag identification code waveform as it would actually be received at said sensors.

41. A method of tracking movement of an object comprising:

placing a plurality of transmitters on the object, each of the transmitters transmitting signals at a transmission rate that is an integer multiple of both 24 transmissions per second and 30 transmissions per second; and

processing the transmitted signals to track movement of the object.

42. The method of claim 41 wherein the transmission rate is 240 transmissions per second.

43. A radio frequency transmission device comprising:

a backing layer;

circuitry affixed to the backing layer for generating a radio frequency waveform;

an antenna for transmitting the waveform;

an adhesive applied to the backing layer;

a removable portion applied to the adhesive;

a sensor for detecting when the removable portion is removed; and

a transmitter controller for enabling the device to begin transmitting the radio frequency waveform when the sensor detects that the removable portion has been removed.

44. The radio frequency transmission device of claim 43 wherein the transmitter controller comprises a switch that enables power from a battery to flow to at least a portion of the circuitry upon detection that the removable portion has been removed.

45. The radio frequency device of claim 43 wherein the removable portion comprises a film or paper layer coated with a release coating in contact with the adhesive, such that the

removable layer may be peeled away thereby activating the device, and the device thereafter adhered to an object by the adhesive.

46. The radio frequency transmission device of claim 43 wherein the device is sufficiently small and flexible to be adhered directly to either a clothed or unclothed human body while allowing substantially full movement of the body.

47. A radio frequency transmission device comprising:

a transmitter;

a power source for powering the transmitter;

a memory for storing data corresponding to a waveform to be transmitted;

a protective cover disposed over at least a portion of the device; and

means for automatically activating the device upon removal of the protective cover.

48. The device of claim 47 wherein the protective cover is a removable layer having a release coating thereon disposed over an adhesive coated portion of the device, and the activating means comprises a switch operated by removal of the removable layer.

49. The device of claim 47 wherein the protective cover is an airtight wrapping surrounding the device, and the activating means comprises an oxygen sensor and a switch for activating the device when the oxygen sensor senses the presence of oxygen.

50. The device of claim 47 wherein the activating means is a photo switch, and the protective cover is an opaque cover disposed over the photo switch.

51. The device of claim 47 further having machine readable indicia on at least one of the device and the protective cover, the machine readable indicia corresponding to a tag identification code transmitted by the device when the device is activated.

52. The device of claim 47 further having indicial readable by a human on at least one of the device and the protective cover, the indicia corresponding to a tag identification code transmitted by the device when the device is activated.

53. The device of claim 51 wherein the machine readable indicia is a bar code.

54. A method comprising:

providing at least three wireless transmitters affixed to a camera to define camera transmitters; and

processing signals received from the camera transmitters to determine movement of the camera.

55. The method of claim 54 wherein the method does not involve using any electromechanical or optical sensors to determine the movement of the camera.

56. The method of claim 54 further comprising correlating the movement of the camera with computer generation of an image onto a scene recorded by the camera.

57. The method of claim 54 further comprising:

providing at least one wireless transmitter defining a reference transmitter at a stationary position; and

wherein the processing step comprises processing signals received from the camera transmitters and from the reference transmitter to determine movement of the camera.

58. The method of claim 54 wherein the transmitters are radio frequency transmitters.

59. The method of claim 54 wherein the camera is a hand held motion picture camera.

60. The method of claim 59 further comprising:

processing an image recorded by the hand held camera and signals received from the transmitters on the camera to remove camera jitter from the recorded image.

61. A system for recording a motion picture image for later processing comprising:

a movable motion picture camera;

a plurality of radio frequency transmitters affixed to the camera;

a reference transmitter not affixed to the camera;

a first processing section for receiving signals transmitted by the transmitters and determining movement of the camera therefrom.

62. The system of claim 61 further comprising:

a second processing section for altering the recorded motion picture image based on said movement of the camera.

63. The system of 62 wherein the transmitters affixed to the camera do not transmit any inertial sensor data.

64. The system of claim 62 wherein the step of altering the recorded image comprises adding at least one computer generated image to the recorded image such that the movement of the camera results in corresponding changes in appearance of the computer generated image.

65. The system of claim 62 wherein the step of altering the recorded imagine comprises removing camera jitter from the recorded image.

66. A motion capture system comprising:

a plurality of wireless transmitters;

a plurality of wireless receivers;

means for determining positions of the wireless transmitters based upon timings of signals received from the transmitters by the receivers without requiring timing clocks of either the transmitters or the receivers to be synchronized.

67. A motion capture system according to claim 66 wherein at least some of the wireless transmitters are located on a movable camera.

68. A motion capture system according to claim 66 wherein:

the wireless transmitters include at least one transmitter disposed at a known location defining a reference transmitter; and

the position determining means comprises means for resolving positions of at least 100 transmitters to within 1 cm of accuracy over a capture zone having a diagonal of at least 50 meters.

69. A motion capture system according to claim 68 wherein the resolving means comprises means for resolving positions of at least 1000 transmitters to less than 1 cm of accuracy over a capture zone of at least 75 meters.

70. A motion capture system according to claim 66 wherein the position determining means includes means for mathematically canceling out transmitter clock dependent terms and receiver clock dependent terms thereby obviating a need for synchronization among transmitters and receivers.

71. A motion capture system according to claim 70 wherein:

the receivers comprise at least four receivers defining sensor receivers spaced apart from one another;

the transmitters include at least one transmitter at a known location defining a reference transmitter and a plurality of transmitters defining marker transmitters attached to at least one moving object, the moving object moving within a capture zone within a reception range of the four receivers;

and wherein the means for mathematically canceling clock dependent terms includes:

means for computing respective single difference terms between marker transmitter received signal parameters and reference transmitter received signal parameters; and

means for computing respective double differences between said single difference terms for pairs of sensor receivers.

72. The motion capture system according to claim 68 wherein the marker transmitters transmit spread spectrum signals in bursts of less than 1 % duty cycle.

73. The motion capture system according to claim 68 wherein the marker transmitters comprise a plurality of groups of marker transmitters, a first group of marker transmitters transmitting spread spectrum signals within a first frequency band, a second group of marker transmitters transmitting spread spectrum signals within a second frequency band, the first and second frequency bands being separated by a guard band.